IN-BEAM γ-RAY MEASUREMENT OF ^{184}Pb

Author: Joonas Ojala

Outline

- Motivation
- Experimental methods and analysis
- Result
- Conclusion

Chart of nuclei

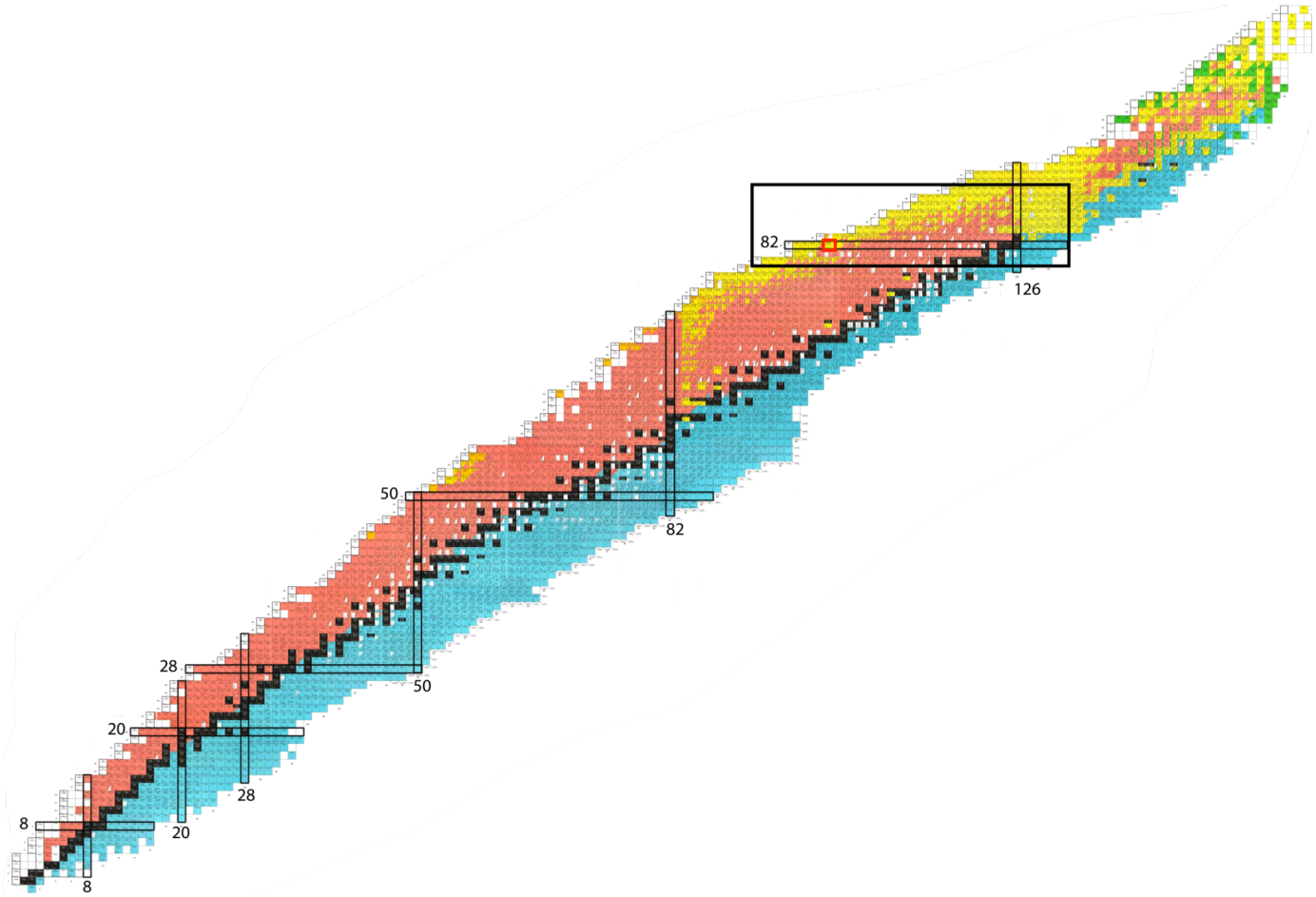
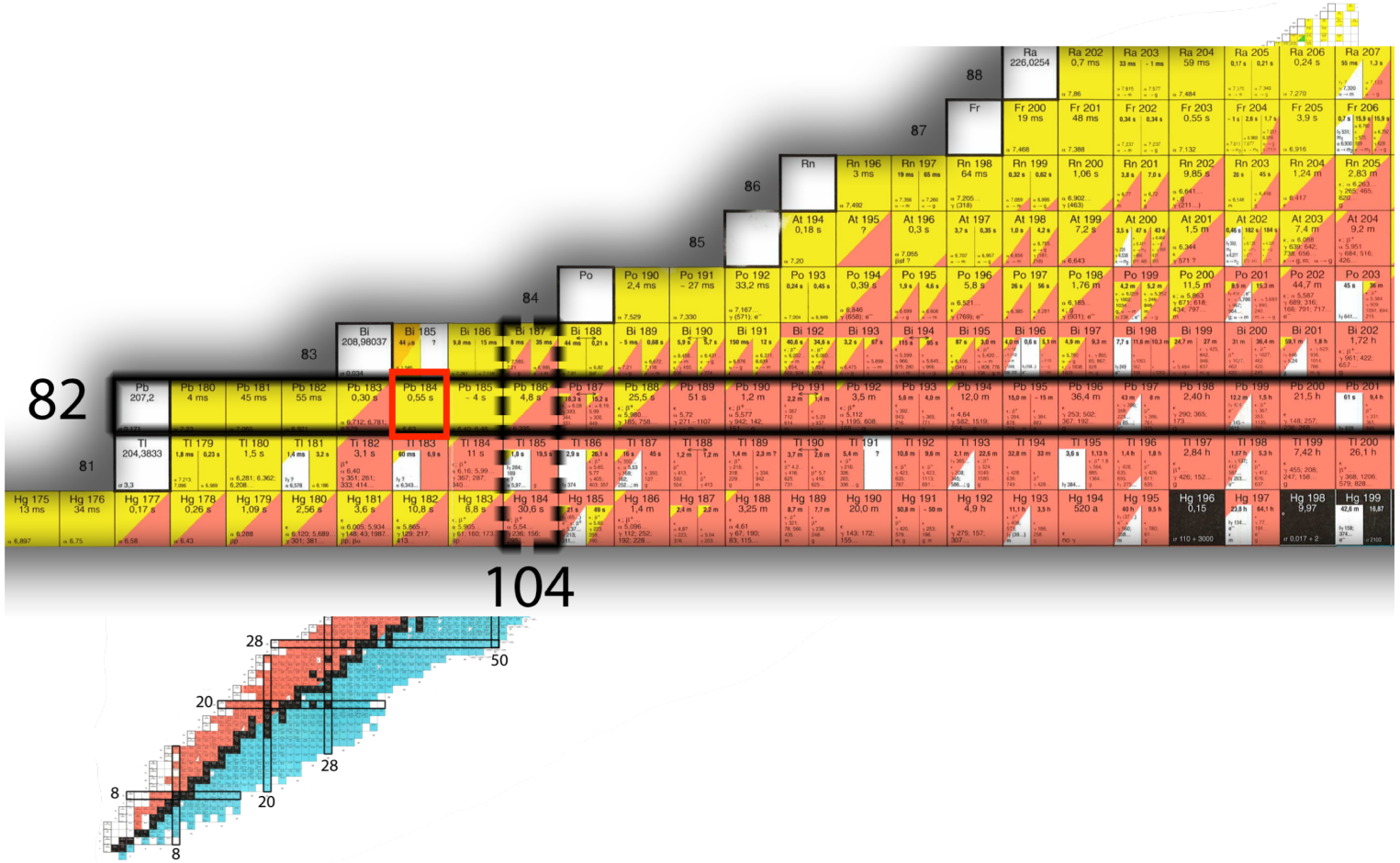


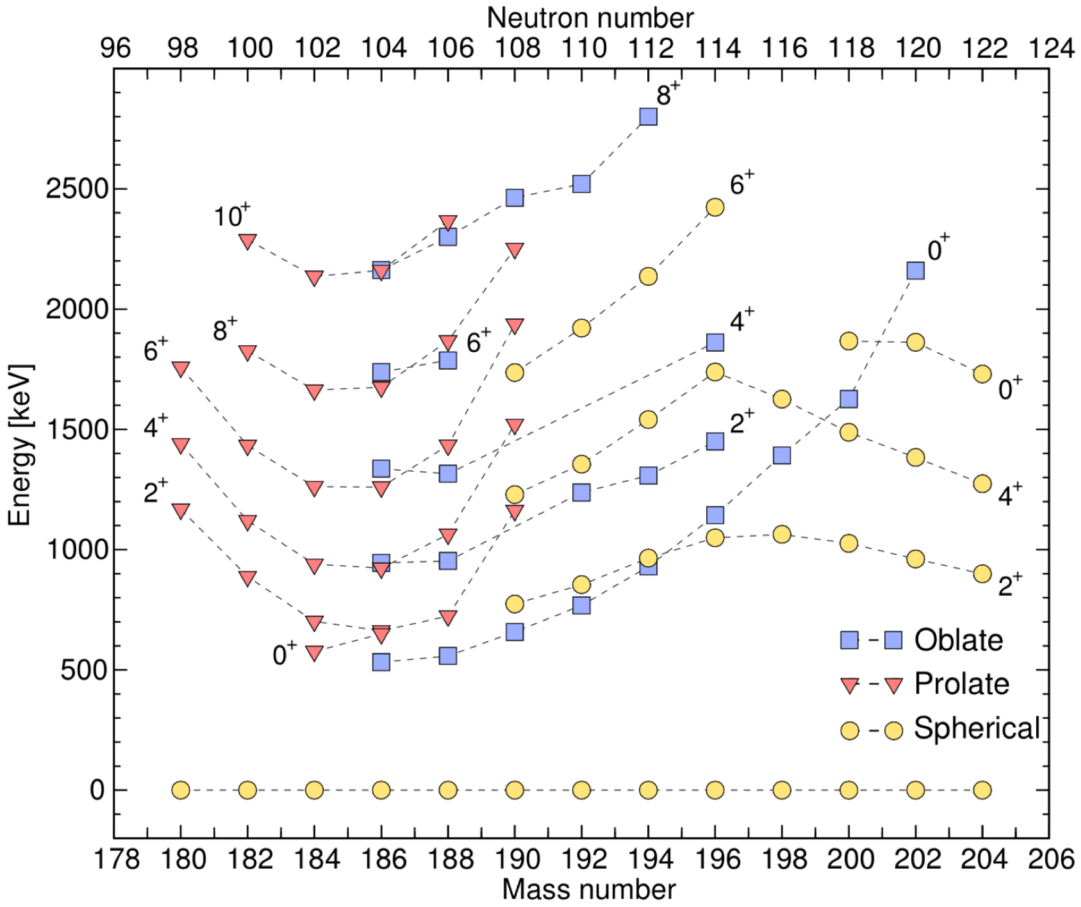
Chart of nuclei



Motivation

- Near the neutron mid-shell in neutron-deficient Pb nuclei, the shape coexistence phenomena has been observed.
- In-beam studies of shape evolution in neutron-deficient Pb isotopes is part of our experimental program.
- Exploring non-yrast structures in Pb isotopes around neutron mid-shell provides stringent test for theoretical models.
- ^{184}Pb can provide information on the development of oblate minimum beyond the neutron mid-shell.

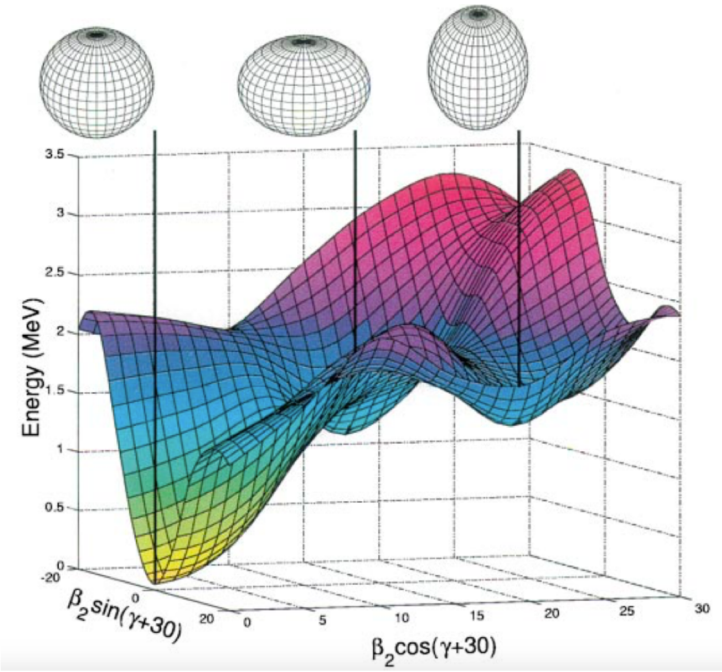
The Pb-isotopes near N~104



R. Julin et al., *J. Phys. G: Nucl. Part. Phys.*, 43(2), 024004 (2016).

Shape coexistence in Pb isotopes near mid-shell

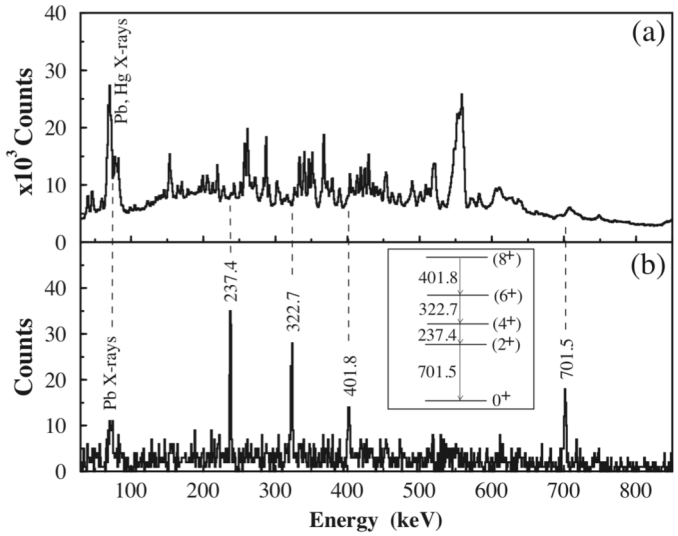
- For ^{190}Pb, ^{188}Pb and ^{186}Pb bands corresponding to two excited minima associated with different shapes (prolate, oblate) have been recognized.
- Prolate and oblate deformation are typically linked with the *4p-4h* and *2p-2h* configurations, respectively.



A. N. Andreyev et al., *Nature,* 405, 430 (2000)

Previous measurements on ^{184}Pb

- ^{184}Pb was identified in 1980 by Schrewe et al.
- First observation of the excited states was done at Jyväskylä in 1998 by Cocks et al.
  - Discovery of the yrast-band
- In 2003, the attempt was made to discover non-yrast structure at Jyväskylä by Wadsworth et al.



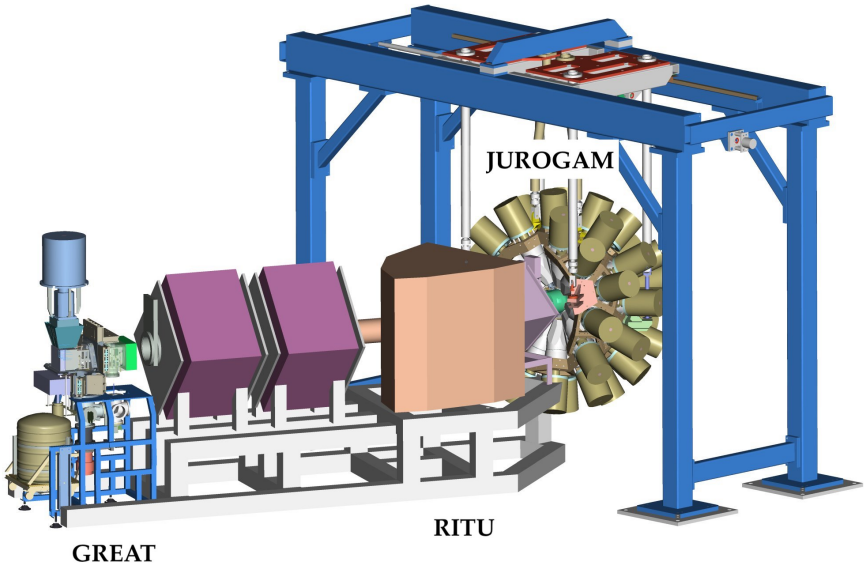
J.F.C. Cocks et al. EPJ A, 3(1):17–20, (1998).

In-beam experiment on ^{184}Pb

- Our experiment was performed in December 2016
- Reaction $^{104}\mathrm{Pd}\left(^{83}\mathrm{Kr}^{15+}, 3n\right)^{184}\mathrm{Pb}$
- Beam energy 354MeV
- Target thickness 1.0mg/cm^2
- Intensity was up to 20pnA
- Beam time ~190h
- Cross section ~3.6μb
- Detected 1.1×10^6 α-particle of $^{184}\mathrm{Pb}$

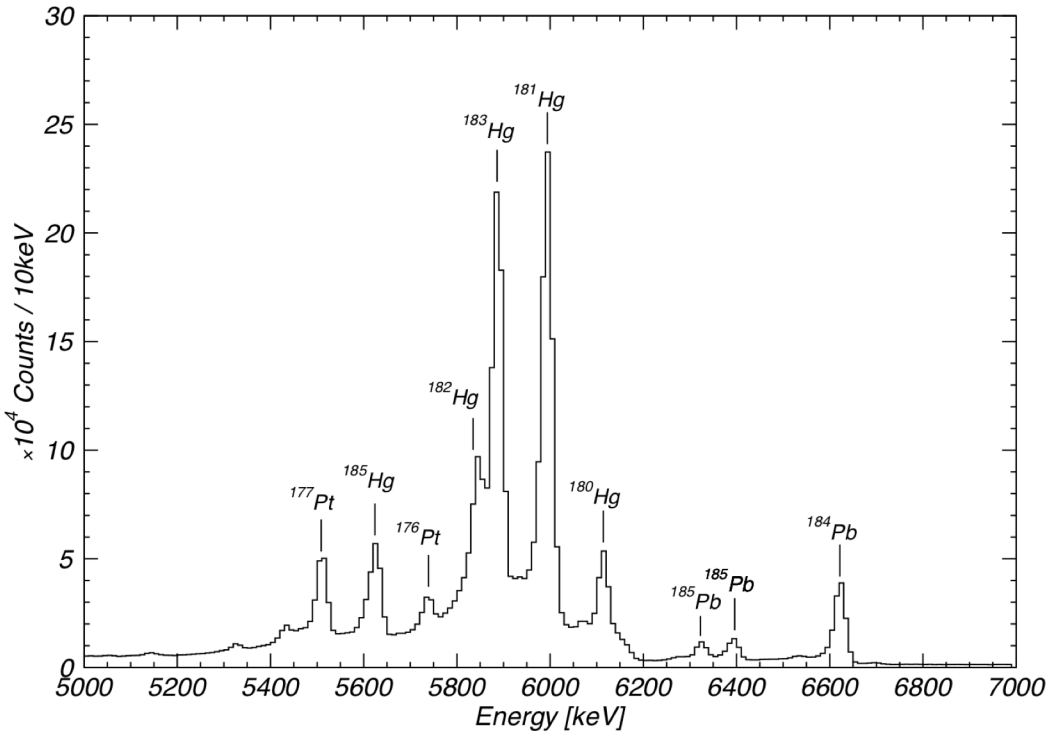
Instrumentation

- Instrumentation JUROGAMII+RITU+ GREAT.
- The JUROGAMII germanium detector array.
- The RITU gas-filled separator.
- The GREAT focal plane spectrometer.

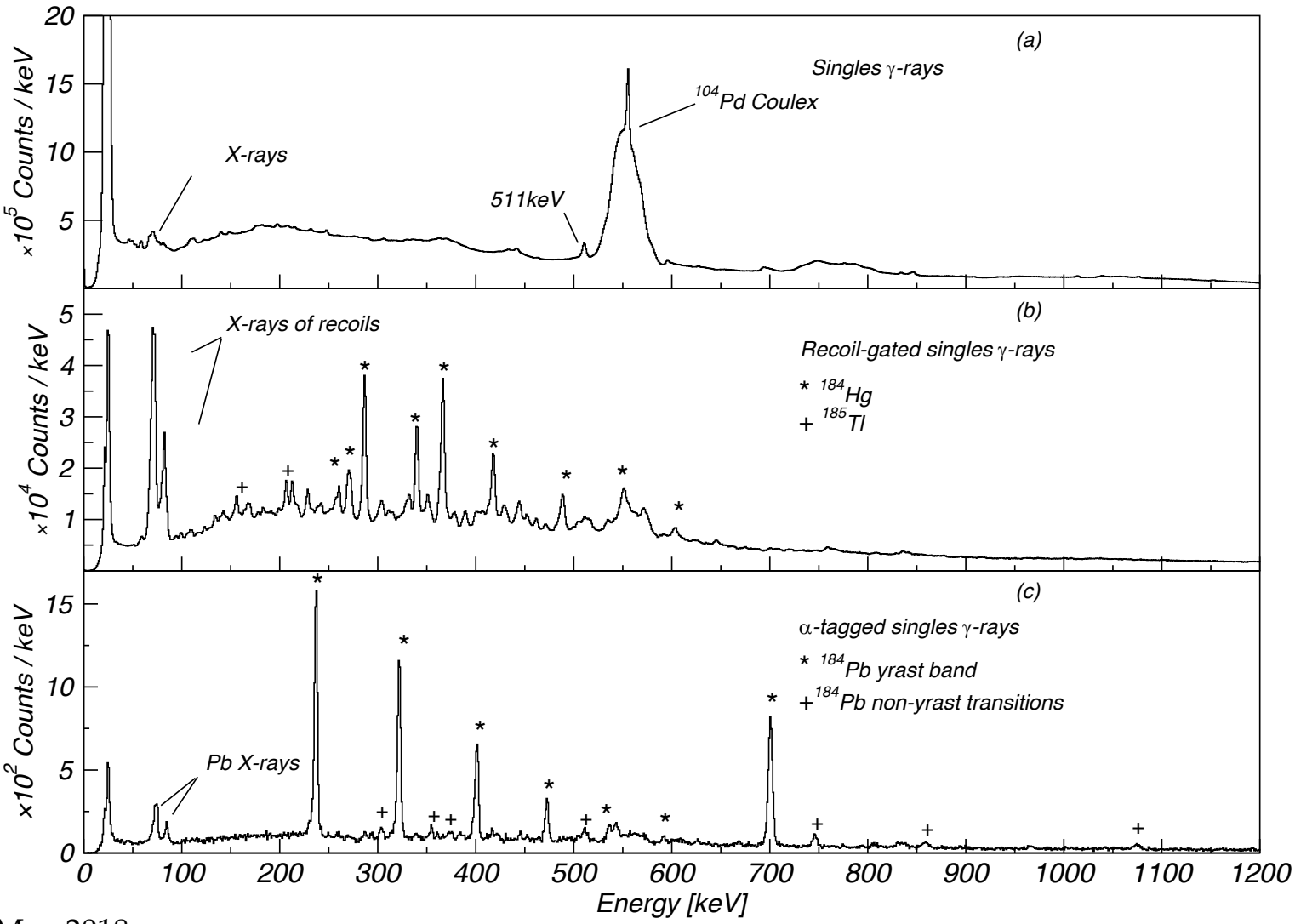


Recoil Decay Tagging

- The RDT technique was employed in experiment
- The events of interest were determined by the detection of a recoil and an α-particle following the decay of $^{184}\mathrm{Pb}$ in the same pixel of DSSD within three half-lives of $^{184}\mathrm{Pb}$.



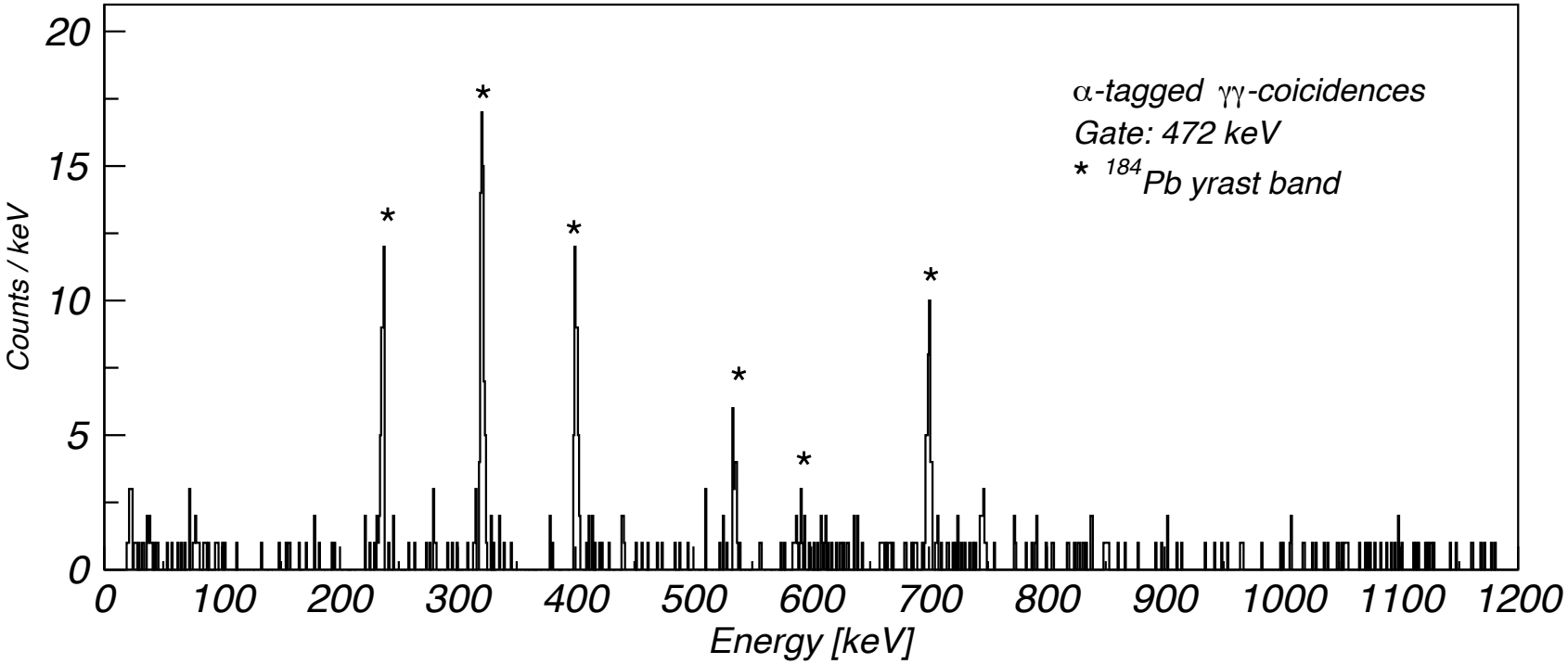
Energy spectra of γ-rays



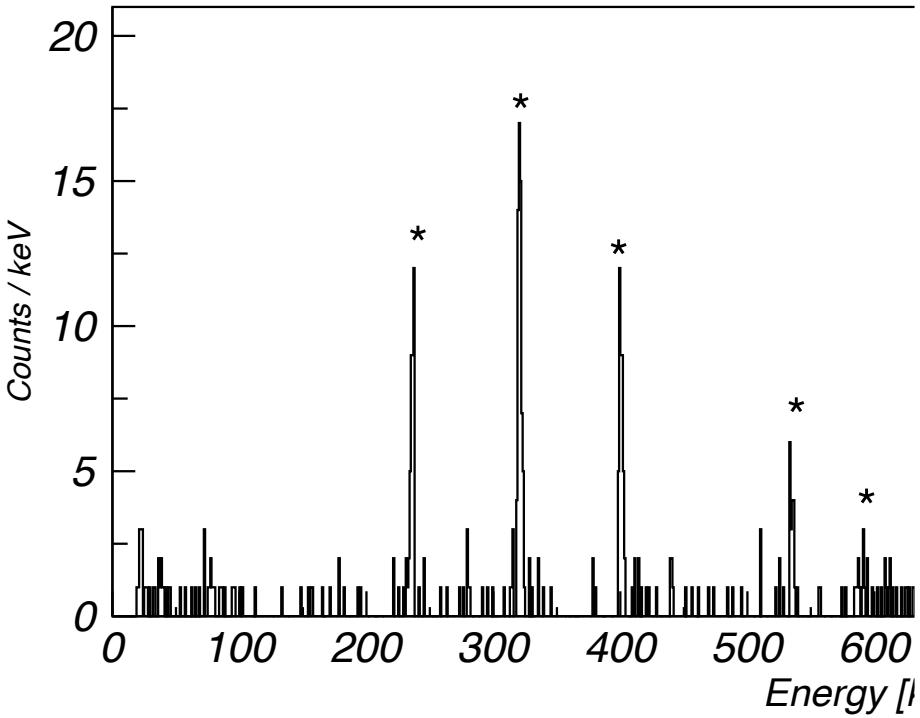
Analysis

- Data was sorted using the GRAIN software package
- $\gamma\gamma$-analysis is conducted with the RADWARE software package.
- Data from previous experiment of ^{184}Pb, measured by Wadsworth et al., was appended.
- As this state of analysis the yrast band has been extended to 14^{+}
- Analysis of the non-yrast structures are problematic due the low statistics.

Yrast band


α-tagged γγ-coicidences
Gate: 472 keV
* 184Pb yrast band
Counts / keV
Energy [keV]
0
5
10
15
20
0
100
200
300
400
500
600
700
800
900
1000
1100
1200

Yrast band


Counts / keV
20
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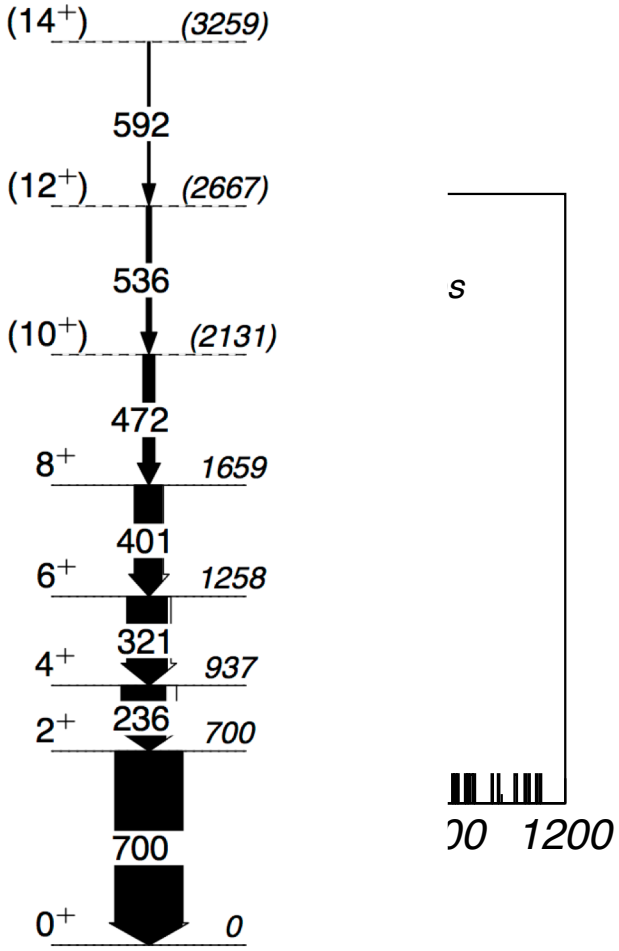
(14+)
(3259)
592
(12+)
(2667)
536
(10+)
(2131)
472
8+
1659
401
6+
1258
321
4+
937
2+
236
700
700
0+
0
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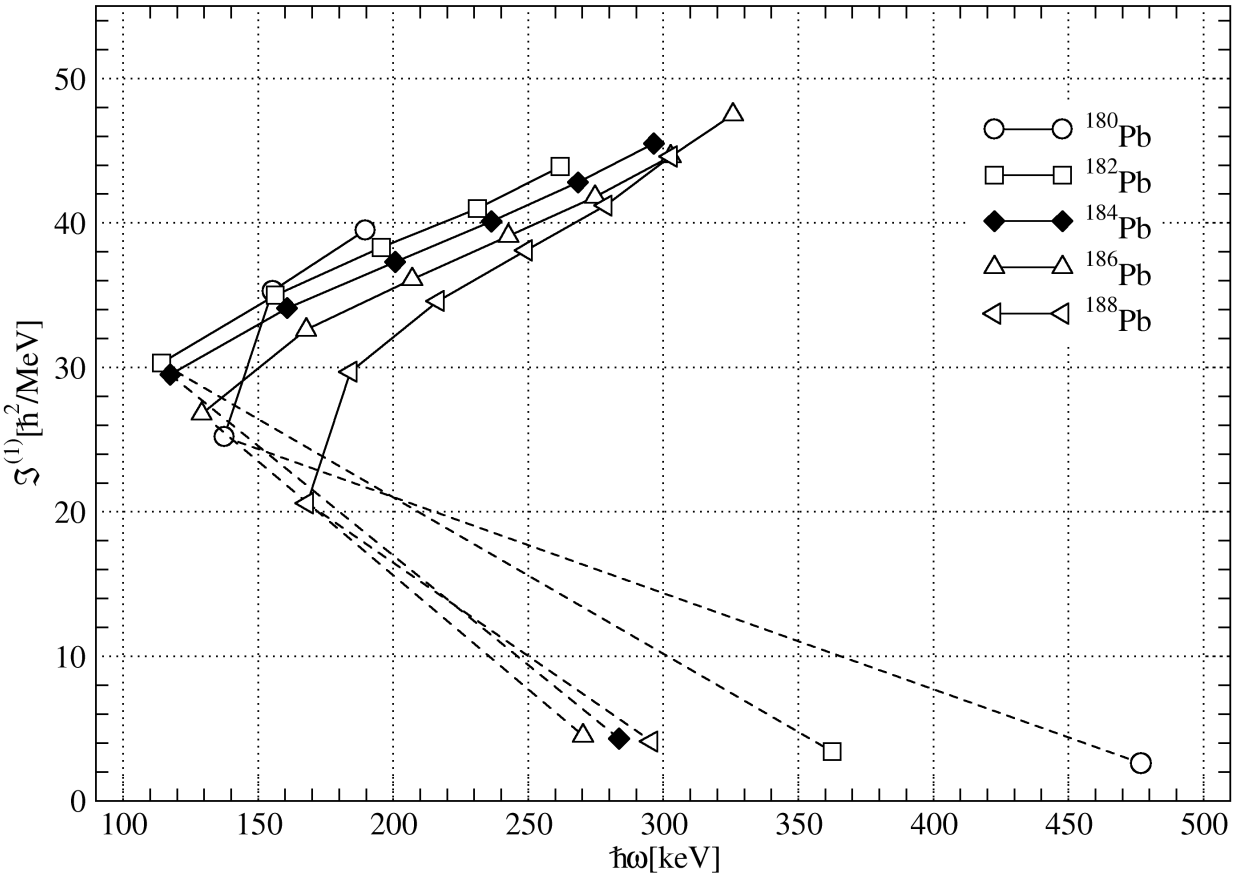
1200

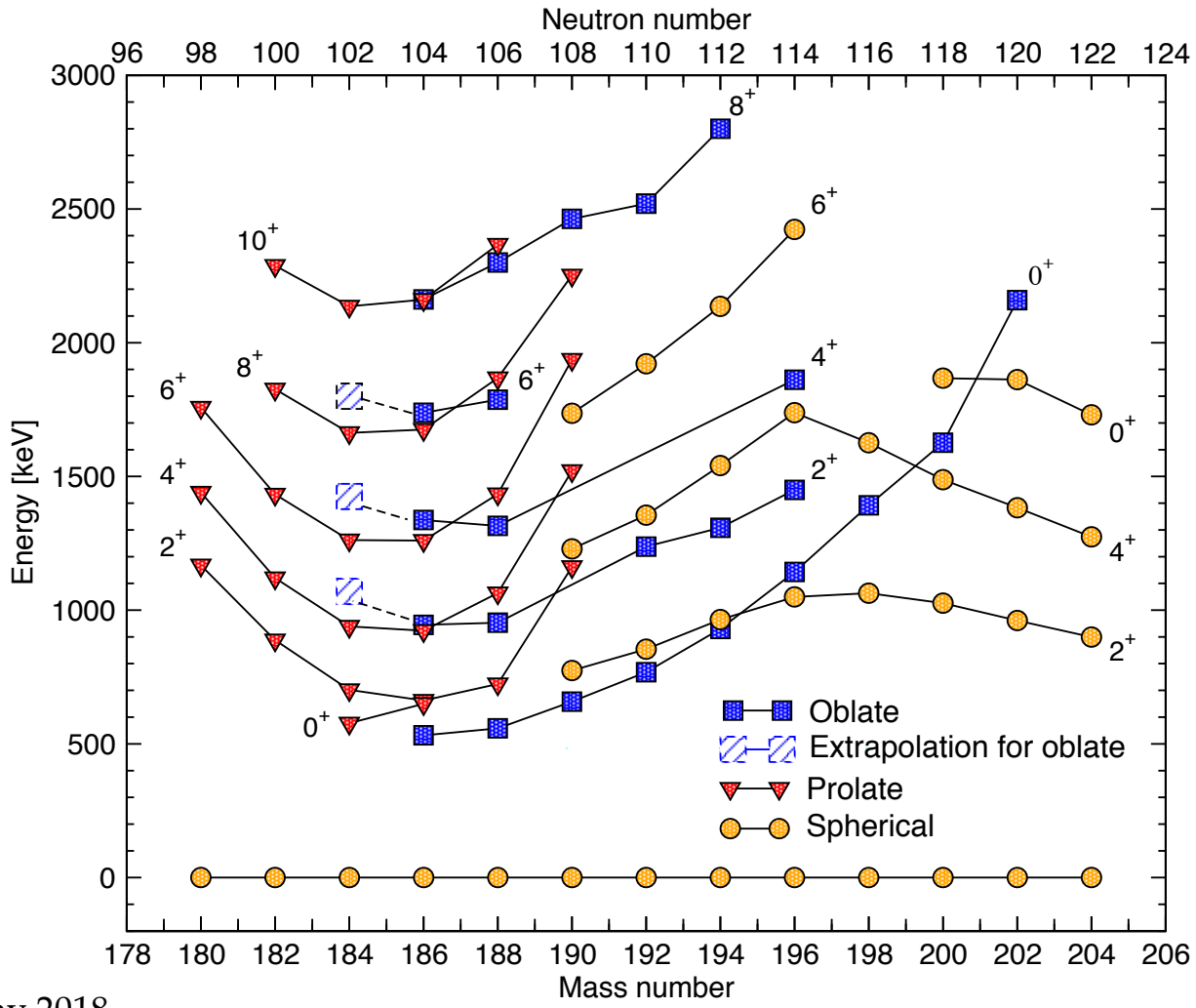
Moments of inertia



$$\hbar\omega \cong \frac{\Delta E_{J,J-2}}{\sqrt{J(J+1)} - \sqrt{(J-1)-(J-2)}}$$

$$\Im^{(1)} \cong \frac{\hbar^2}{2\hbar\omega} \frac{(4J-2)}{\sqrt{J(J+1)} - \sqrt{(J-1)-(J-2)}}$$

Possible oblate states?



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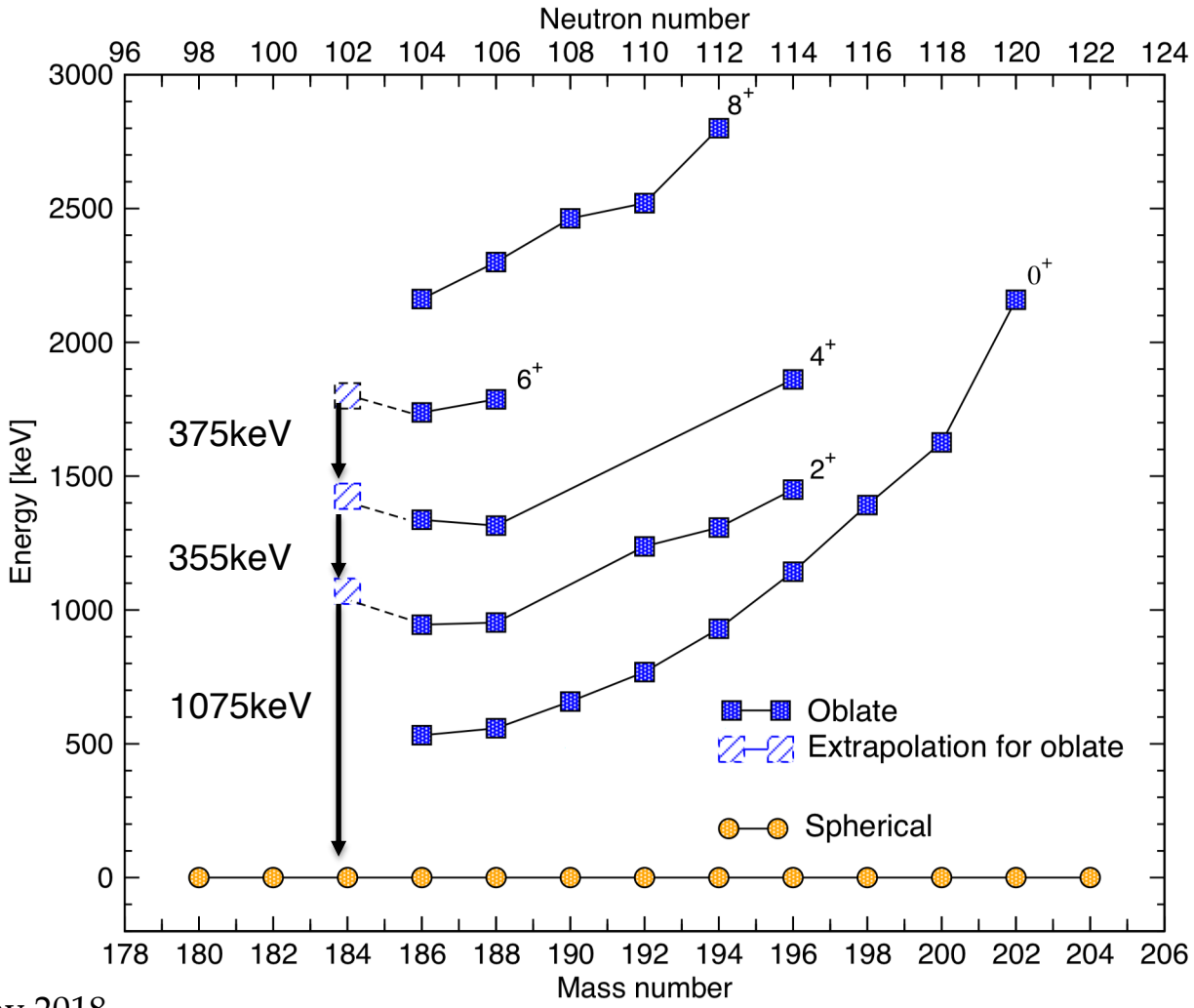
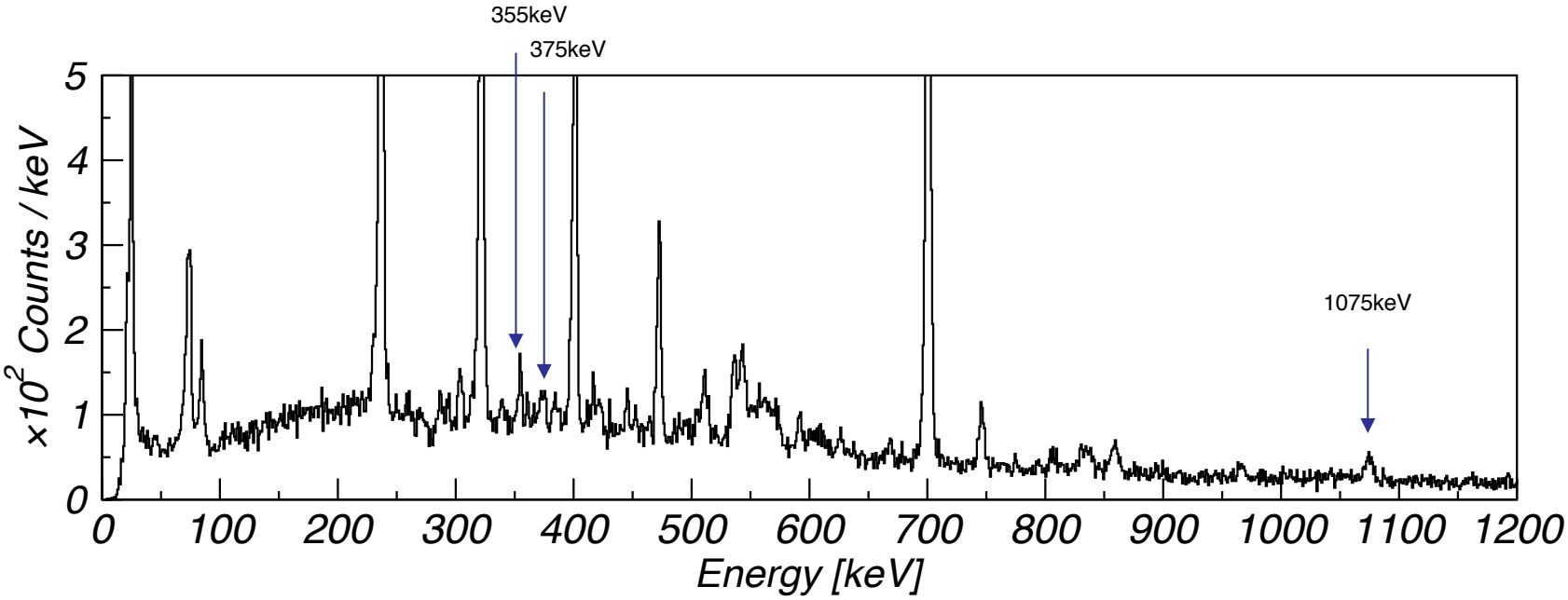
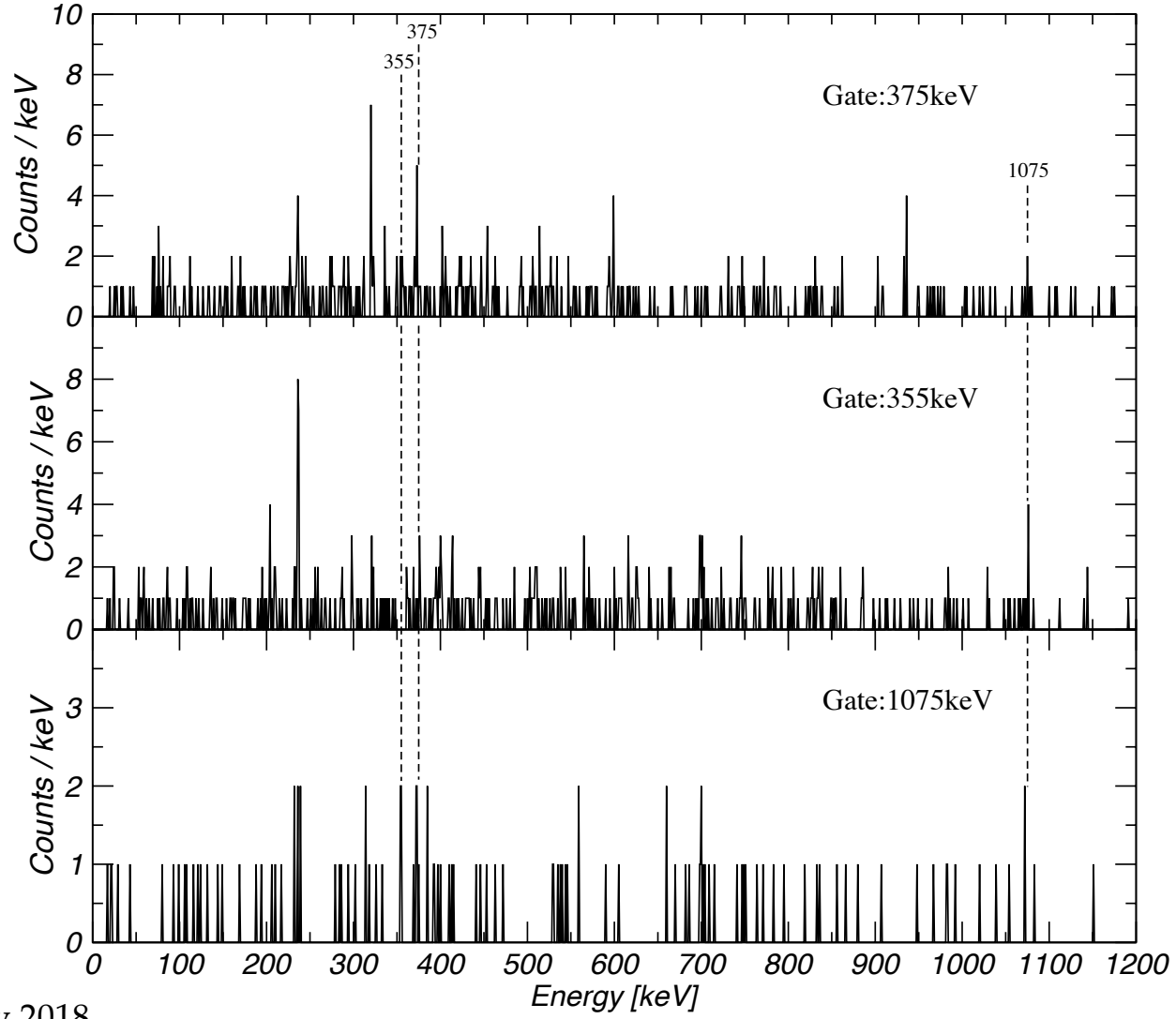


Possible oblate states?



Coincidences



Conclusion

- Our data provide evidence for the extension of the yrast band up to spin $I^{\pi} = 14^{+}$.
- In addition, several transitions not belonging to the yrast band have been identified.
- However, even with improved statistics, determination of possible non-yrast structures in $^{184}\mathrm{Pb}$ are demanding due to the lack of $\gamma\gamma$ -coincidence statistics.

Collaboration

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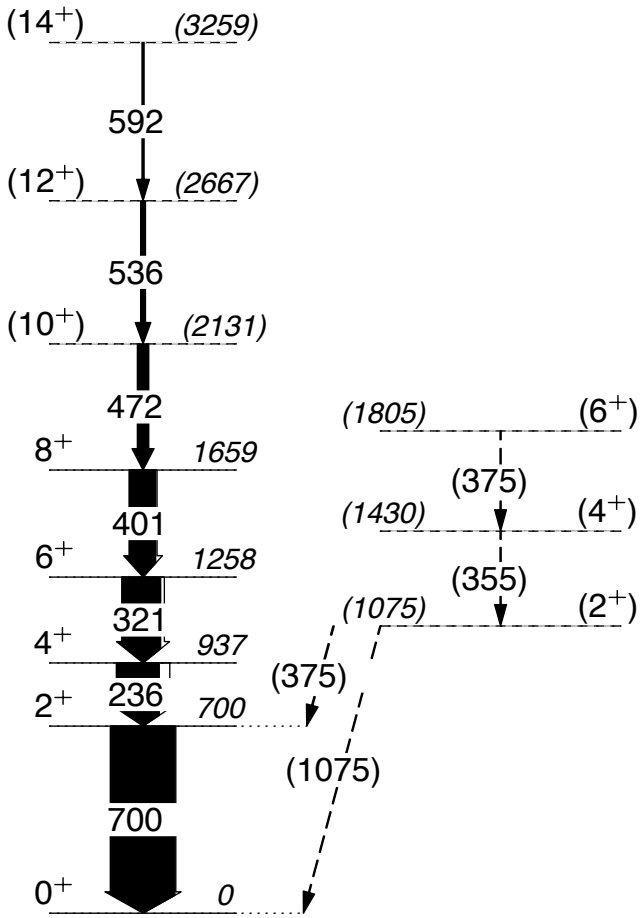
R. Wadsworth , A. Brown, R. Llewellyn, B. WalliS

University of Liverpool

A. Briscoe

Thank you for your attention!


(14+)
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236
2+
700
700
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0
(1805)
(6+)
(375)
(1430)
(4+)
(355)
(1075)
(2+)
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